MONTANA TEEN DRIVER CURRICULUM 2.0 GUIDE
Lesson Plan & Teacher Commentary

Module 4.2 – Curves and Hills

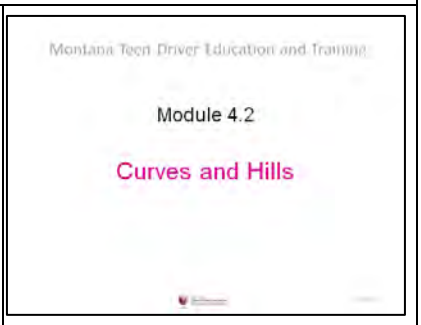
Lesson Objective:

The student is expected to:
(a) describe and respond to line-of-sight and path-of-travel restrictions;
(b) describe and demonstrate proper approach to hills or curves;
(c) describe and demonstrate proper speed for ascending and descending hills;
(d) describe and demonstrate proper entry speed and lane positions for a hill or curves;
(e) describe and demonstrate proper speed and lane positions in a curves' apex;
(f) demonstrate proper speed and lane positions for exiting curves; and
(g) describe conditions that can affect traction and procedures to maintain traction in curves.

Materials Needed:

1. **Module 4.2 PowerPoint Presentation**
2. **Module 4.2 Fact and Work Sheets (printed out)**
3. **Module 4.2 Lesson Plan/Teacher Commentary (printed out)**

Slide 1 – Curves and Hills

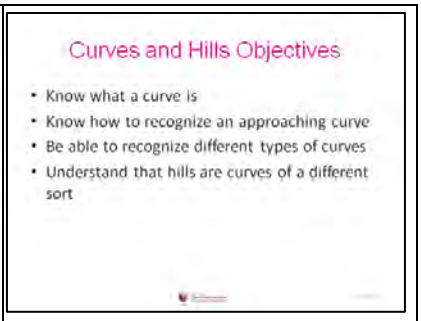


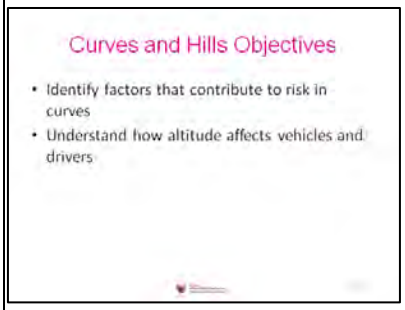
We drive in a world that is not a straight line; neither is it perfectly flat. Because hills and curves cause us to redirect the energy of a vehicle that is dependent on road design and surfaces, we need to pay close attention to the shapes of curves, elevation changes in curves, and roadway design of curves.

This module will help students develop the skills needed to recognize an upcoming curve or hill, identify the type of curve, evaluate the surface of the curve and then safely drive through curves while maintaining their car on the roadway.

Slides 2 & 3 - Objectives

- **Know what a curve is.**
- **Know how to recognize an approaching curve.**
- **Be able to recognize different types of curves.**
- **Understand that hills are curves of a different sort.**
- **Identify factors that contribute to risk in curves.**
- **Understand how altitude affects vehicles and drivers.**



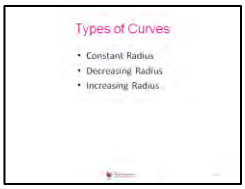


Slide 4 – Video

This video demonstrates to the viewer that we all must obey natural laws (laws of physics) while driving—especially in curves. Use this video as an opportunity to review natural laws with your students so they can relate to how their car behaves in curves and on hills.

Slide 5 – Types of Curves

- **Constant Radius**
- **Decreasing Radius**
- **Increasing Radius**



Slide 6 – Constant Radius Curves

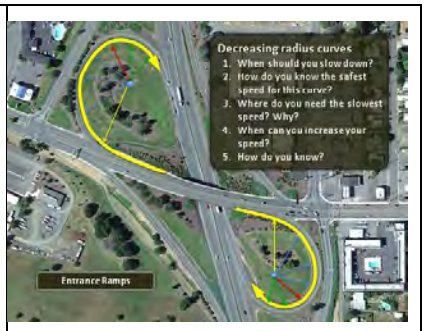
The arrows indicate that the radius of the curve is constant from the entrance or beginning of the curve to the exit or end of the curve.

- **The driver should reduce their speed as they begin to take the curve indicated by the yellow arrow.**
- **The red arrow indicates the apex of the curve and where the slowest speed needs to be so the driver can manage the forces in the curve.**
- **The green arrow is where the driver can begin to accelerate because their transition peg is in line with the target as they exit the curve. The car will stay in balance as the driver begins to accelerate and straightening the wheel.**

Slide 7 – Decreasing Radius Curves

On a decreasing radius curve the curve gets sharper as you drive through it. It is common to see these on entrance ramps for freeways.

The process of exiting this curve is to select a target at the exit of the curve and when your transition peg crosses the target you can begin accelerating to freeway speed.



Slide 8 – Increasing Radius Curves

In essence the curve gets straighter the further you get into the curve. The driver should be slowing just after exiting the freeway (yellow arrow).

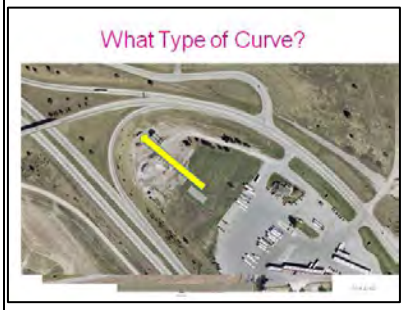
- **The slowest speed should be at the sharpest part of the curve (red arrow) or shortest radius, or about the third arrow on the diagram.**
- **The driver can know the best speed for this curve by understanding that exit ramps traditionally are a increasing radius by design and the sharpest part of the curve is early in the curve.**
- **Best speed for the curve will be indicated by a sign posted at the start of the curve.**

Slide 9 – I-15 and I-90 at Butte

The driver, traveling at 70 MPH or faster, needs to slow to 25 MPH before they get to the decreasing radius of the curve (yellow arrow).

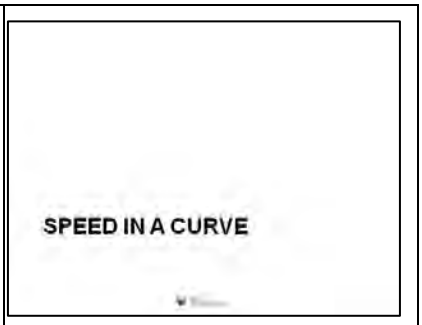
Slide 10 – What Type of Curve?

1. **Constant Radius**
2. **Decreasing Radius**
3. **Constant Radius**
4. **Decreasing Radius**
5. **Increasing Radius**



Slide 11

Most single vehicle crashes occur on curves. The most common reason is the driver was going too fast when they entered the curve.

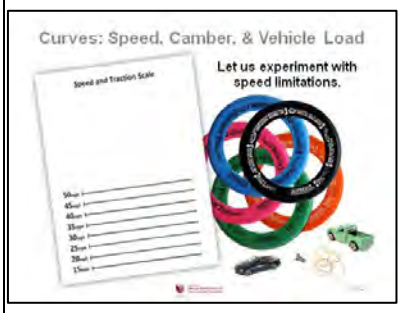


Slide 12 – Why does speed kill in curves?

Slide 13 – Video on cars and curves, and obeying the laws of physics.

Slides 14 and 15 Curves: Speed, Camber & Load

Refer to the Curves Work Sheet for materials needed and how to conduct the student activity.



Slide 18 – Vehicle Contributes to Risk

Animation starts when you open this slide (words and phrases appear one by one).

Slide 19 – Roadway Design – Positive Slope

Questions you may want to ask:

1. **Which direction does your body want to go when running through this curve?**
2. **Does the runner stay on track or does the runner go down the slope?**
3. **What can the runner do to stay in the curve?**
4. **You may want to do this as a student activity if weather permits and you have these kinds of slopes at your school. You can see what the students are doing and you can have your students repeat these activities and answer the questions.**

Slide 20 – Roadway Design – Positive Slope

Based on what you learned from the last slide, predict how the car will handle this upcoming curve and what you need to do to keep the car on track in the curve?

Slide 21 – Roadway Design – Negative Slope

Questions you may want to ask:

1. **Which direction does your body want to go when running through this curve?**
2. **Does the runner stay on track or does the runner go down the slope?**
3. **What can the runner do to stay in the curve?**

Slide 22 – Roadway Design – Negative Slope

Based on what you learned from the last slide, predict how the car will handle this upcoming curve and what you need to do to keep the car on track in the curve?

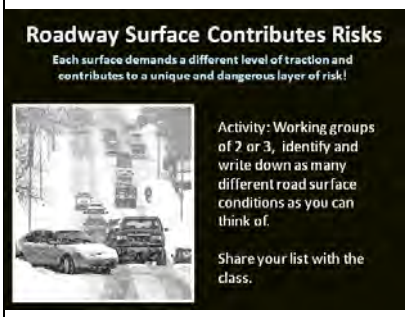
Slide 23 – Roadway Design and Vehicle Load

Here is a roundabout outside Helena. There are several things that the driver of this truck needs to consider. Questions you may want to ask:

1. **Describe what is happening to this truck in vehicle balance terms: roll, pitch, and yaw.**
2. **What does the driver need to do to manage the forces and vehicle dynamics in this curve?**
3. **When should he have started taking action to effectively manage the balance and forces?**
4. **Early detection in treating illness gives the patient and doctor more options for treating and managing a disease. The same is true for driving. If you detect a change early you have more options in managing natural laws and keeping a car in balance and on the road.**

Slide 24 – Roadway Surface Contributes Risk

Flat, blacktop, oil, banked + or -, leaves, polished, ice, concrete, snow, gravel, crowned, water, sand.



Slide 25 – Describe the following …

Dry pavement gives us the greatest traction and allows us to redirect the energy of the vehicle more effectively than other surface conditions. We still need to account for all the other factors such as curve radius, roadway design, speed control, and lane position.

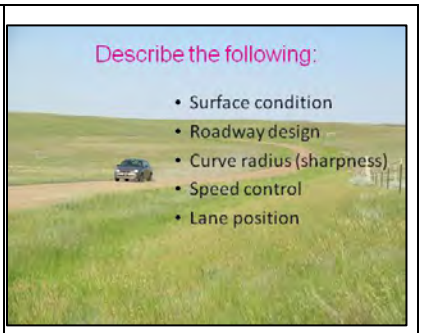
Slide 26 – Describe the following …

The surface condition is now wet which means our traction is not as effective as the last curve we reviewed. What does the driver need to do to account for less traction?

Slide 27 – Describe the following …

Gravel presents a traction problem for the driver because gravel often acts like driving on marbles or ball bearings. It will cause the car to drift out of a curve. The picture also shows the roadway design is a negative slope and will also contribute to the vehicle moving out of its lane.

What does the driver need to do to manage the traction issues created by the gravel road and the roadway design?



Slide 28 – Describe the following …

Same issues as the last slide except we don't know what is happening with the road as it drops out of view. What does the driver need to do to manage the risks of this road on this curve and hill?

Slide 29 – Describe the following …

Seasonal road surface changes cause us to alter the way we drive around curves.
Questions you may want to ask:

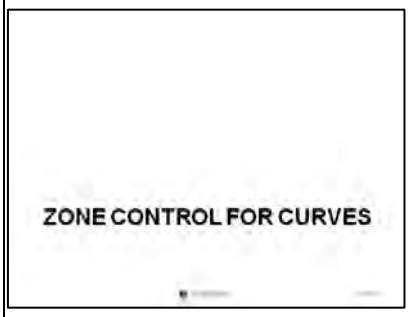
1. **What does this driver need to do to manage the risk of driving through this curve?**
2. **What will happen if the driver loses traction in the middle of the curve?**
3. **What does the driver need to do to minimize the risk of traction loss?**
4. **When should the driver slow down for this curve?**

Slide 30 – Zone Control for Curves

Find-Solve-Control will help the driver address the unique issues that curves present.

This is a great place to review the Zone Control System and have the students identify:

- **Find—Where to find curves in your Path of Travel—in your target area**
- **Solve—Where to solve how to safely drive through a curve—in your 15 second range**
- **Control—Where to put into action the decisions you made in the Solve step and make any last minute adjustments—4-second danger zone.**



Slide 31 – FIND

Find the curve in your target area. There are many tools to help the driver find a curve. What do you think they might be?

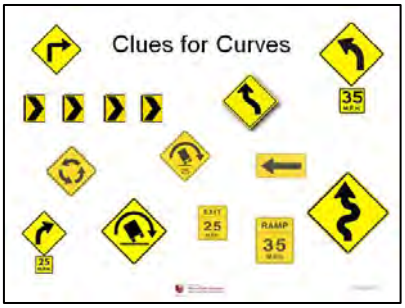
Slide 32 – Clues for Curves

This is a sample of the signs drivers might see that will alert a driver to an upcoming curve. The sign provides critical information about the direction of a curve, how sharp it might be, and what speed the driver is advised to take the curve.

Sometimes curves don't have signs to warn the driver of a curve up ahead. There are other ways to recognize approaching curves. Have the students identify other ways they might see an upcoming curve.

Suggestions might be:

- **The paint on the road curves**
- **The power poles are curving around the road**
- **There are trees at the end of the road**
- **The road disappears to the right or left**



Slide 33 – Visual clues for curves

There are several clues that the driver can identify.

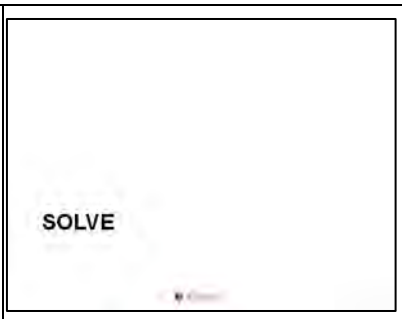
1. **The sign**
2. **The speed under the curve sign**
3. **The yellow line curves to the right**
4. **The chevrons at the end of the road**
5. **The tree line at the end of the curve**
6. **The curving white line**

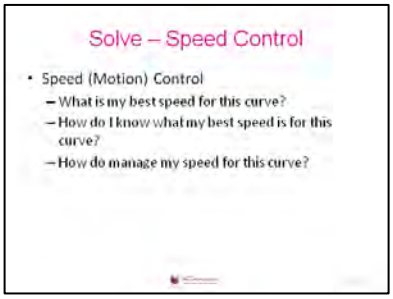
Have students get used to looking for more than just the sign. There are many times when there is no sign and the curve can end up surprising the driver.

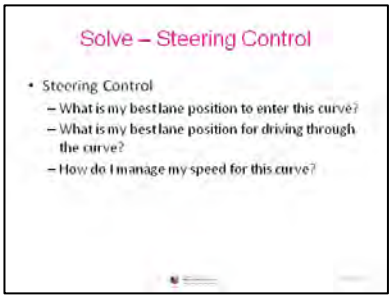
Slides 34, 35 & 36 – SOLVE, Speed & Steering Control

After the driver sees that they are approaching a curve he or she must decide what speed control and lane position options they will employ.

- **Manage speed first and then establish a driveline to manage the natural laws as you drive through the curve.**
- **Speed signs posted below the curve ahead give the driver the safe speed for a curve on dry pavement with good visibility.**
- **When you add rain, snow or ice to a curve, it's best to slow down and drive with care.**





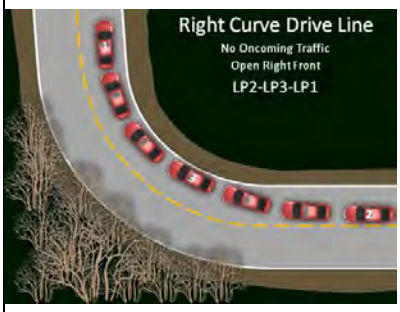


Slides 37 & 38 – Right Curve Drive Line

Driveline for a right curve with no oncoming traffic and open right front.

Upon entry to the curve, LP 2 gives the driver a better view around the the curve and also helps set up for the driveline through the curve.

At the apex, the driver is at LP 3 and at exit LP 1. Avoid going to LP 2 at exit to create space between possible oncoming traffic.



Slide 39 – Right Curve Drive Line

The only difference for this is a closed left front by oncoming traffic, so the driver needs to enter the curve at LP 1.

Slide 40 – Right Curve Drive Line

With closed right and left the only option for the driver is LP 1. When that is the case the driver must also reduce his speed further than he would normally drive through the curve.

Slide 41 – Left Curve Drive Line

Upon entry to the curve the driver moves to LP 3 to get a better view through the curve and set up the drive line for the curve.

At the apex the driver moves to LP 1. More experienced drivers might move to LP 2 but that creates risk by moving the driver closer to possible oncoming traffic.

At exit the driver should move to LP 1.

Slide 42 – Left Curve Drive Line

When right and left zones are closed, the driver's only option is LP 1. As mentioned before, if LP 1 is the only option for the driver he must reduce his speed further than if he were normally driving the curve without obstruction.

Slide 43 – Vision Control and Driveline

The purpose of this video is to train the students to use their central vision to see through the curve and select a target at the exit to the curve and to see their lane position (driveline) with their fringe vision.

Have students identify what lane position the car is in at the entrance of the curve, at the middle of the curve, and at the exit of the curve.

Help the students understand that this video also demonstrates the driveline through a curve.

Slide 44 – Hills

Issues that the driver needs to pay attention to when driving on hills.

1. **Line-of-sight restrictions—can't see through or over a hill.**
2. **Change from uphill to downhill or downhill to uphill will cause the car to speed up or slow down.**
3. **Traction issues when it's snowy or icy.**
4. **Slow moving vehicles blocking your path or line of sight.**

Slide 45 – Hills and Mountains

- **A hill can rise and descend gently, or can be part of a mountain range**
- **Gravity is every driver's passenger when traveling up and down hills**

Slide 46 – Adjusting speed for uphill

You are approaching a hill. You know that the effect of gravity will cause your car to slow down. At what point do you need to increase your accelerator pressure to make sure you stay at the same speed?

Slide 47 – Slow-moving Vehicles

Heavy vehicles are naturally slow on hills. They create line-of-sight issues for the driver, preventing her from seeing oncoming traffic and upcoming curves. The tendency for drivers is to follow too closely thus increasing the LOS blockages by the truck. Staying back a little further allows the driver to see the road ahead of the truck and make informed decisions about where it is safe to pass or where they just need to sit back and enjoy the ride.

Later on you will learn about altitude and engine performance. Briefly, the higher you are the less power your vehicle has to make a pass.

Slide 48 – Hills – Downhill

The biggest issue with going downhill is that gravity causes our vehicles to speed up. We need to know when and how to manage speed going downhill to ensure that our brakes don't overheat and fail.

Slide 49 – Speed Control – Where?

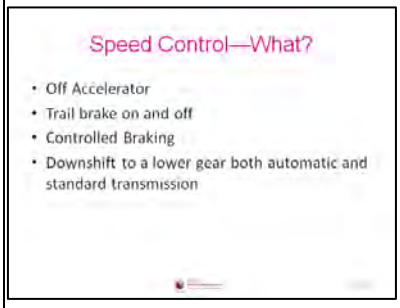
Hover over the video to see the play bar pop up and you can replay the video if you want the students to identify where they should begin to slow down.

Some students keep the same accelerator pressure as they crest a hill and don't realize that the car will speed up as it goes over the hill.

Watch the video and have the students say aloud when they should ease off the accelerator and explain why they need to slow down where they do.

Slide 50 – Speed Control – What?

- **Gravity causes the car to speed up.**
- **Braking causes the brake rotors and pads to heat up and become less effective.**
- **Manage your speed at the top of the hill to keep your speed in check during the rest of the hill.**
- **Sometimes speed can be managed by simply reducing accelerator pressure and letting the engine compression slow the car.**
- **Trail brake on and off means that the driver applies trail brake pressure to slow and then comes off the brake to allow them to cool and then reapplies the brake as the vehicle begins to speed.**



Slide 51 – Runaway Truck Escape Ramps

Brakes can become overheated and lose their effectiveness. Highway engineers design runaway ramps to give runaway trucks a place to stop. They have deep gravel which helps slow the truck quickly and safely.

Several things to remember:

1. **They are for runaway vehicles only.**
2. **You can become stuck in a runaway ramp because the gravel is loose and deep.**
3. **You should not park in front of a runaway ramp.**

As you can see by this second picture these runaway ramps are used to stop runaway trucks.
BECAUSE SOMETIMES THEY ARE NEEDED

Slides 53 and 54 – Altitude

Higher altitude means less oxygen. Less oxygen means fuel doesn't burn as effectively. Lower efficiency means lower performance—lower power, slower acceleration.

The same is true for drivers. Drivers need oxygen to burn the fuel needed to think clearly and move their muscles. At high altitudes, drivers think more slowly and can't respond as quickly to situations that develop.